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ABSTRACT

This report describes educational applications of slow-scan television (SSTV) teleconferencing, which uses a video signal generated from a standard, low-cost, industrial television camera and compressed to a bandwidth suitable for transmission over telephone lines. Following a brief explanation of the capabilities of SSTV and the required equipment, project descriptions illustrate the educational advantages of SSTV. Projects noted include (1) elementary and secondary programs in South Bend Indiana and Hancock, Michigan; (2) programs at the University of Wisconsin, Yuba College (California), California State University at Chico, Colorado State University, Colby Community College (Kansas), the University of Hawaii, Northwestern University (Illinois), and the Massachusetts Institute of Technology; (3) library research programs of the Federal Library Committee and the University of Cincinnati Medical Center Library; and (4) medical teaching and consultation at the University of Toronto and the Memorial University of Newfoundland. Advantages of SSTV addressed include its ability to visually enhance instruction; make available specialized courses that are often inaccessible; meet specific local educational needs without the production expense of regular television; and make scarce and/or distant intellectual and research resources and personnel available to a wide audience. (LMM)

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TELE-EDUCATION:

Teaching Over The Telephone

TELE-EDUCATION

Teaching Over the Telephone With Slow-Scan Video

By Kathleen Kelleher, Colorado Video, Inc.

Good communication is the essence of good teaching, and teachers are finding that, by incorporating new interactive telecommunications technology into their curricula, their ability to communicate effectively is greatly enhanced. As instructors at every level of teaching, from elementary school to the university, and in a wide variety of fields, from sociology to medicine to engineering, have found, slow-scan television is a successful teaching tool.

Slow-scan video teleconferencing is a simple and inexpensive way for an instructor to interact verbally and visually with students located at a different site. It allows the teacher to "travel" by telephone to the students, and vice versa, without having to sacrifice the visual content of the instruction. Schematics, charts, photographs, x-rays, sample math problems written on the blackboard — all can be transmitted by regular telephone lines.

Dr. James Tangeman, President of Colby Community College in Colby Kansas, has found that the potential for slow-scan video to deliver courses to people at remote locations "lies in the fact that the courses can be made available wherever there's a telephone."

The maximization of a teacher's expertise by making it more widely available and the relatively low costs of a slow-scan video teleconference (after the purchase of the equipment, the cost is merely the long-distance charge) combine to make slow-scan video teleconferencing an inexpensive teaching aid.

"Slow-scan" television technology presently uses a standard, low-cost, industrial TV camera coupled with a small device which compresses the video signal to a bandwidth suitable for transmission over phone lines. "The overall system is comparable to a television slide projector and does not, of course, reproduce moving images," said Glen Southworth, President of Colorado Video, Inc., a leading manufacturer of slow-scan television equipment. "For most course instruction work, this is not a handicap, particularly as the significant visual content of the instruction usually involves stationary material, equations, graphs, charts or still photographs."

The SSTV classroom can be kept quite simple. It is designed so the TV teacher may also serve as director, camera person, and audio engineer. A small control panel provides all controls for switching camera, slide changes and transmitting converter. Expensive studio equipment and space are not needed. Telephone lines are used for both transmission of pictures and voice; they allow questions to be asked of the instructor from the remotely-located classroom.

Setting up an ad hoc slow-scan video teleconference requires an ordinary TV monitor, a portable TV camera, a slow-scan TV transceiver and its support equipment (a portable pack contains control boxes and a modified telephone) plus, of course, a room with plug-in jacks. One telephone line is used for audio, and the other is used to transmit and receive the pictures. The TV camera focuses on the speaker or the illustration, a frame is "frozen," and then this image is transmitted via telephone lines. The audience then sees a series of still images, each requiring about 35 seconds to develop on the TV screen. More than one camera can be used, one to focus on the speaker and one to view illustrative graphics. The audio at the receiving end can be connected to an amplifier enabling a group of persons to listen to the speaker while watching the speaker and/or graphics on the TV screen(s).

Unlike interactive closed-circuit television and AT&T's Picturephone, which require specialized and expensive communications channels, SSTV permits pictures to be transmitted from a camera at one location to a TV receiver at another location using only an ordinary telephone line. Together with audio communications, SSTV provides a two-way, completely interactive audio/

visual capability between two or many points accessed by ordinary telephone connections. The only limitations are that just still pictures can be sent and that a small delay in transmission time is involved.

SSTV In Elementary and Secondary Education

Project STIMULUS (Slow-Scan Television Instructional Motivation Ultimate Learning Unique Strategy), a one-year federally funded pilot project carried out by the South Bend, Indiana Community School Corporation, was designed with several purposes in mind. Howard Uhrig, Project Director, said that the main idea was to maximize the talents and expertise of teachers within the school district. "We wanted something inexpensive, interactive and that called on the active participation of students and teachers," he said. The programming included reading for second and third grades, aimed specifically at teaching consonant and vowel discrimination and identification. Project STIMULUS also included institutional programs in music theory for high school seniors and career education at the second and third grade levels.

One of Uhrig's major concerns that he hoped SSTV would ameliorate was the lack of teacher participation when media was used. "I see teachers play 16mm film for the students, and while the film is playing they are busy doing their grading. They don't get involved in the reaction-type process, and therefore they can't get maximum use out of the audio/visual process." When Uhrig visited classrooms using SSTV, he found that "the kids were very attentive to what was going on." Teachers, too, were more involved. They designed the programs, actively participated in helping children interact with the medium (filling out worksheets, picking out correct answers, etc.) and took care of the audio and camera equipment. "Our teachers enjoyed this," said Uhrig, "and they asked for opportunities to use SSTV."

A similar SSTV project was carried out in the Copper Country Intermediate School District in Hancock, Michigan. As part of an innovative educational project funded by state and federal grants, the project's main goal was to identify and meet the specific needs of students as well as teachers located in the Western Upper Peninsula of Michigan, where approximately 300,000 persons are sparsely settled over 20,000 square miles. During a four-year period, SSTV made courses available to students who were unable to travel to an educational site due to long distances and heavy snow conditions. Previously unavailable instruction, including courses in music, dental hygiene and upper-elementary math instruction, were brought into kindergarten through high school classrooms.

"It worked. It was very effective and very cost-effective," said John Kirscher, Project Director. His assessment, he said, was based on a careful monitoring of the project through design controls and control groups built into the study plan (a stipulation of the federal/state grant that the results of the project be clearly demonstrated). "Yes, no question about it, the project was successful."

Its success, Kirscher said, could be attributed to the medium of SSTV, with its economy of production and its ability to serve specific, local needs, without having to appeal to a large audience to justify regular TV's high production costs. "Teachers were always involved," Kirscher said, "but they chose the type and level of involvement." By polling teachers, Kirscher and others on the project staff identified areas of educational need, and they then located "teacher-producers" and helped them develop program series. There was a very ambitious math fractions series that Kirscher said he believed was "a real godsend for teachers who have a difficult time teaching fractions." The project was especially successful in music, "because these kids came virtually ignorant of music," he said.

The approach was a comprehensive one, filling in gaps for students and upgrading teachers' skills according to what they said they needed. In-service teacher training was made readily accessible and very convenient to teachers by linking SSTV programming to cable TV, thus allowing teachers to do the majority of their coursework at home.

"We used cable to extend the reach of SSTV," said Kirscher, "enabling us to offer some programming for the general population that met local needs, such as classes in cold-weather insulation." The SSTV mode of teaching, he found, was most effective at the lower elementary

levels: "I was surprised again and again how enthusiastic they were about it."

The Electronic University Degree

In the face of the "knowledge explosion" of our "information-rich" society, education is necessarily being viewed as a life-long process. Many universities are meeting the challenge of offering continuing education to a student population that is also a working population. SSTV is increasingly being recognized as a teaching channel that closes the gap between the educational institution and the society it serves.

The University of Wisconsin-Extension has a long tradition of continuing education and outreach throughout the state. Today, after several years of experimenting with various broadcast and non-broadcast technologies, the university's extension program has operationalized a SSTV video teleconferencing network that links together 20 different sites in the state.

"A few years ago, we realized that instructors were using micro-computers quite a bit, but not for teaching," said Lorne Parker, Director of the Center for Interactive Programs, "so we looked for a way to integrate computer technology with classroom teaching." Student response to SSTV is excellent, Parker said. "Students enjoy the instantaneous graphics, the ability to see the instructor, and instantaneous interaction." The SSTV network, which has been in operation at the university since last fall, means that now "the boundaries of the campus are the boundaries of the state," Parker said.

From the University of Wisconsin, Parker teaches a course "electronically" at New York University's Tish School of the Arts in the masters-level Inter-Active Telecommunications Program. The course is taught together with Martin Elton, a professor of communications at NYU who designed and was the first chairman of the masters degree program. In addition to its use to teach courses electronically so as to access distant expertise and at the same time provide "hands-on" experience for the students, Elton said that SSTV has been used for ad hoc events, like bringing into the classroom a guest lecturer located in another city. NYU's School of Education is planning to offer SSTV courses for professional educators working on degrees at the Graduate Resident Center at the College of the Sacred Heart in Puerto Rico and SSTV will visually enhance a variety of ongoing and audio-conferenced continuing education courses offered by NYU to students in Puerto Rico.

"With full-motion videoconferencing, if one wants to connect with many points, it can only be transmitted out in one direction," said Elton, who has carried out extensive research and authored more than 20 articles on telecommunications, "there isn't any interaction. Some people make the mistake of thinking that SSTV is a 'cheaper, second best,'" he added, "when actually it gives some capabilities that full-motion videoconferencing cannot. Full-motion videoconferencing can't carry out symmetrical multi-point interaction." Going beyond the "hype" that surrounds promotions of interactive technology, Elton said, "What I like about SSTV is that it is easy to interconnect more than two points simultaneously, it's easy to arrange, and it can easily go overseas." Another advantage is that it allows visual feedback from students: "With SSTV, the speaker gets the benefit of facial expression and thus can target his or her presentation more appropriately," said Corey Bock, a graduate student of Elton's.

At Yuba College in Marysville, California, SSTV is used at the receiving end to pick up images of the students taking courses via cable and to transmit their images and their work back to the professor and class at the site of instruction. Royd Weintraub, Director of the Instructional Media Center at California State University at Chico, said, "SSTV is supplementary to the whole operation."

Microwave ITFS (Instructional Television Fixed Service) is used to hook up to cable and make available instruction in 14 cities, covering 25 percent of California's area. High-speed digital and computer terminals have the capacity to access all libraries in the school system through the on-line catalogue provided by Ohio College Library System.

California State University at Chico and the university at Davis are electronically linked together, said Weintraub, allowing six community colleges to share facilities and expenses. This system makes available to the population four different places of learning: the home, the neighborhood (elementary school, hospital), the community college (where instructor and students

meet occasionally), and the industrial plant (Hewlett-Packard, for instance, offers its workers regular California State University courses at the workplace). "Rather than seeing it as an extension program, we consider it as an integral part of the regular instructional program," said Weintraub. There is no separate registration for students studying long-distance; they can use "auto-dial" telephones to the library, and the libraries are readily available electronically through the College Library System Inc. California State at Chico can thus offer B.A. and graduate degrees in their Para-Legal and Social Science Programs and in the Department of Education.

The "wired university," said Weintraub, is particularly suited for an older audience, people already in their careers, and those who are isolated, especially the disabled. "The major advantage of SSTV is the interactive nature of the link-up," he said. Although the university does not have a great deal of resources to invest in program production, he said this was not a hindrance to the educational process. "People can simply converse," he said. "I think that interaction is the ticket. If and when we have more funds, we can devote more to production. But the main thing is that this system lets people interact."

SSTV has been used to augment curricula of colleges that do not have the resources to offer specialized courses in some of their degree programs. Colorado State University sponsored a program, CO-TIE (Cooperation via Televised Instruction in Education), that offered engineering courses to four schools throughout Colorado: Northeastern Junior College in Sterling, Arapahoe Junior College in Littleton, Otero Junior College in La Junta and Trinidad State Junior College in Trinidad. Dr. Lee Maxwell, a professor in the Electrical Engineering Department at Colorado State who participated in CO-TIE, said "SSTV is especially useful for transmitting pictures of pieces of engineering equipment." He said that SSTV was also used successfully for tutorials for engineering students around the state, allowing them to interact on an informal basis with professors at Colorado State and thus benefit from expertise in a type of interaction otherwise unavailable to them.

A fairly typical problem faced by community colleges is a shortage of instructors to meet the demands of a widely-scattered student population that, because it is also a working population, cannot readily travel. Dr. James Tangeman, President of Colby Community College in Colby, Kansas, said that his college served 23 different centers, located anywhere from 30 to 100 miles away from the main campus. Colby Community College had previously experimented with electronic blackboards, but they were found inferior to video teleconferencing because they were not interactive. "In video teleconferencing," said Tangeman, "I could see a lot of application to instruction, especially because it lets the instructor and student interact. Teaching accounting and solving accounting problems, for example, takes both visual and verbal interaction, and video teleconferencing lets you do this. It is a unique solution for effectively and inexpensively getting a lot of information out."

SSTV has also made it possible for professors to take advantage of national-level expertise when designing their curricula. Dr. David Swift of the Sociology Department at the University of Hawaii utilized SSTV to bring into his Sociology of Exploration class as a guest lecturer a well-known NASA scientist. He scheduled a long-distance video teleconference with an eminent scientist at NASA's Ames Research Center. A portable SSTV video teleconference pack was air-freighted ahead to Ames Research Center. At the predesignated time, Dr. Swift put through the telephone call to the scientist at NASA. Immediately, the scientist was "in the classroom," addressing the students, answering their questions, responding to their ideas — in short, interacting with them. Used in this fashion, SSTV allows both a "conservation" and a "dissemination" of scarce knowledge. The scientist's limited time and intellectual energy were not spent in exhausting travel, a "brain drain" that could have also meant opportunity costs to NASA; and, likewise, on the "receiving end," the students were afforded the opportunity to converse directly with a nationally-acclaimed authority.

SSTV has also made it possible to bring the classroom to where the students are. In one case, classes were held for engi-

neers on site at Motorola's Communication Division in Schaumburg, Illinois. The participants were enrolled as regular students in a Northwestern University Technological Institute four-week course entitled "Human Factors in Engineering." The students, the organization and the university all benefitted. Students were able to receive certificates from Northwestern by studying during their lunch hour at the workplace. Motorola benefitted by its link-up with newly-acquired knowledge and the university benefitted by its link-up with Motorola, because it could combine students in different sites, including its own campus, to meet the required enrollment level for a single class.

"The model of a teacher using a blackboard or overhead projector indicates that motion is not necessary in most teaching situations," said Professor William Cohen of Northwestern University. "With two-way voice communication, we retain the live interaction which is such an important part of the student-teacher relation. Our goal is to bring the essentials of the classroom to anyone who has access to a telephone and to create a true 'university without walls.'"

Professor Stuart L. Meyer, the other project director, said he felt that teaching with SSTV was just as effective as face-to-face teaching. He has extensively monitored different teaching formats — live, closed-circuit and slow-scan — and has come to the conclusion that "the results are indistinguishable. People totally forget that it is still motion." Meyer also served as a consultant for an educational project funded by the Department of Health and Human Services at Cook County Jail in Chicago, where he helped introduce SSTV into PACE (Programmed Activities for Correctional Education), which made it possible for inmates to link up with outside job opportunities, social services, drug-abuse counselling and educational courses. Additionally, SSTV made it possible for inmates to "visit" with their families. While he had originally been concerned that the still images of the families wouldn't convey the message in that type of situation, Meyer found that "nobody even mentioned that the pictures didn't move!"

One innovative use of SSTV in education is being made by Bernde Kracke, a research fellow at the Center for Advanced Visual Studies at Massachusetts Institute of Technology. Kracke combines scientific research with artistic exploration. He recently arranged an "interactive performance" between the Visible Language Workshop at MIT and the Exploratorium in San Francisco, the purpose of which was to demonstrate basic scientific concepts and recent developments in a direct, "hands-on" manner. Various electronic means, including pre-recorded videotape and live closed-circuit TV at a site that used video as a live feed-back system, were employed to obtain images which were then transmitted from San Francisco to MIT via SSTV, at which point the images were digitally processed, transformed, and augmented by an electronic collage. These electronic collages were then transmitted back to the site at the Exploratorium. "It was a well-received two-hour performance," Kracke said. "The kids and adults interacted with the exhibits to understand in a playful way what scientific developments mean first-hand."

Video art has also been transmitted intercontinentally between MIT and Zurich and between MIT and Vienna using this method. "SSTV is attractive due to its availability and relative low cost," said Kracke, who teaches and carries out research in telecommunications. In contrast, "involvement with satellite is very expensive and necessitates that a lot of people be involved; plus there's always a limited period of time when it's available. It is a very luxurious tool." SSTV, he said, "is a very personal tool for teleconferencing. It doesn't involve a lot of people or companies."

Library Research

In addition to its use in the classroom, SSTV is also being used to facilitate research. The Federal Library Committee, comprised of a network of 15 federal libraries located all over the United States, sponsored a project funded by the National Science Foundation to test applications of state-of-the-art technology for library research. The basic premise for incorporating SSTV and telefacsimile into the library research system was that it would overcome the library's dependence on the often slow and cumbersome U.S. mail system. "If the library doesn't have what the

researcher needs, then we request it of the other libraries through Inter-Library Loan," said John Welsh, Library Systems Analyst at the Department of Commerce National Oceanic and Atmospheric Administration (NOAA) library in Boulder, Colorado. "The faster you can get materials to the researcher, the more productive the researcher will be. Also the less frustrated.

"Initially, our purpose in installing SSTV equipment was to be able to let our patrons visually review material before sending it to them via telefacsimile," Welsh said. "However, we just didn't use it as much as we felt we could. Patrons didn't see the need for it. They would say, 'Just get me such and such,' and they didn't care how they got it, just as long as it was quick." The decision was therefore made to use SSTV to carry out functions for which telefacsimile was neither suited nor convenient. These included training, workshops, instructions and writing on the blackboard, Welsh said. "Also, if there was someone new in our library network, we would transmit pictures of them to other sites. We even used SSTV to show people how to use their facsimile equipment!" To take full advantage of either SSTV or telefacsimile, "you really have to gear the material to the medium," said Welsh. "One gets a true sense of three-dimensionality with it, and one gets a sense of real time."

The University of Cincinnati Medical Center Library has established the Telecommunications Information Network (TIN) to make available medical information and services to health-care professionals at four rural and semi-rural hospitals in Southwest Ohio. Telephone requests are researched by the staffs of the Health Sciences Library and the Drug and Poison Center. The requested information is conveyed to health-care providers via telephone and/or SSTV. "A surgeon at one of the small rural hospitals called in for a diagram on how to carry out a paraticular type of surgery," said Susan Anthony, Director of Information Services at the Medical Center Library. "We found exactly what the surgeon was looking for, transmitted it, and as a result, he was able to visualize it clearly."

It was originally thought that TIN would primarily provide quick answers to patient care questions for first-line health professionals, such as physicians, nurses and pharmacists; but the experience of TIN to date suggests a more varied use. Questions about patient treatment have accounted for only one-third of all requests. TIN has been heavily used to respond to information requests regarding hospital administrative decisions, teaching and research. Anthony said that clinicians, dieticians, nurses, surgeons and administrators all requested information through TIN. The library staff has found that health-care providers want more than literature citations; they want assistance and answers to their specific questions. "We provide specialized medical information ordinarily unavailable at remote cities," she said, "and this runs the gamut from researching an EKG supervisor's request for procedures on how to do stress testing, to visiting policies for intensive care units, to surgical techniques for bronchial cleft cysts. SSTV is especially good for transmitting graphs and abstracts of articles."

Medical Teaching and Consultation

Since 1972, Dr. Earl Dunn, a professor on the faculty of medicine at the University of Toronto, has considered the uses of interactive technology for purposes of medical teaching and consultation. In 1977, eight SSTV units were installed, three in hospitals and the remainder in communities scattered throughout Northwest Ontario. These communities have populations of 50 to 1,000, are difficult if not impossible to reach and generally have only health stations administered by nurses or volunteers. On a weekly basis, since May of 1978, SSTV has made possible a medical educational program for doctors and nurses at the different sites, consisting of a 30-minute lecture followed by a discussion in which all the participants can interact, using a Darome bridge which hooks together the SSTV-equipped communities. And for the past three years, the participating hospitals in Toronto have carried out a nursing educational program once a week, with a nurse clinical specialist offering instruction designed specifically for the nurses in the region. The hospital at Sioux Lookout also has an ongoing SSTV project, one that allows the doctors there to transmit x-rays to Toronto for analysis, as well as a program out of Sioux Lookout for the outlying communities. Research funds were available for these projects from 1977 to 1980, but since that time, said Dr. Dunn, "there has been

no money and technicians, only the SSTV equipment provided by Colorado Video, Inc., and the energies of volunteer workers." Although extensive cost analyses have been carried out, Dr. Dunn said the best measure of success "is the fact that, after four years, people are still partaking and want more programs."

Dr. Dunn said he felt that SSTV was particularly well-suited to situations where small groups of people needed to interact. "The communities can be hooked together with the Darome bridge, and so everyone can see and hear everyone else and transmit their own x-rays and particular cases. People can present their own patient problems more effectively because it is interactive. We very commonly have case discussions on problems that people have in their own community. Someone can show up with an x-ray, and we can see it and discuss it.

"We don't need to use SSTV if there is no need to transmit x-rays or other pictorial information," Dunn went on. "We can call and determine this, and if the images are not on the agenda, we can save money be utilizing only one telephone line." SSTV is especially useful, he said, for transmitting x-rays. "Radiologists have no trouble interpreting the x-rays transmitted via SSTV. In fact, with respect to soft-tissue x-rays, one can get an even better picture with SSTV due to its zoom capacity. The quality of the original x-ray is more important than the transmission. If there's a good x-ray, you'll get a good transmission of it. If the x-ray isn't good to begin with, then, of course, it can't transmit well either."

Dr. Dunn has also used the SSTV system to teleconference. From Toronto, he addressed a professional medical audience in Madison, Wisconsin, via SSTV, and interacted directly with them during the question-and-answer period. "This way," he said, "we could demonstrate the equipment, and I could participate when otherwise I could not have gone to Wisconsin."

Dr. Max House, Associate Dean for Continuing Medical and Clinical Affairs at Memorial University of Newfoundland, has also used SSTV for medical purposes. He said he felt SSTV was best utilized to support medical consultation. "A doctor can send x-rays to a radiologist, and the x-ray analysis is invaluable information for the diagnosis."

An experimental project is being planned in which SSTV equipment will be put on an oil drill rig off-shore in the Grand Banks. Once into the production stage, there will be three or four rigs in each oil field equipped with SSTV. "The medical usage would comprise about 20 percent," Dr. House estimated, "with company business conferences and equipment repair consultation comprising the rest." SSTV will be especially useful for medical consultation in situations where a picture of an injured eye or extremity, for example, can be transmitted to shore, allowing an opthamologist or an orthopedic surgeon to advise the medic on the rig about proper procedures to be taken. Dr. House stressed the value of this additional pictorial information for the doctor's diagnosis.

Tele-Teaching and Research

SSTV, either alone or linked with other interactive technologies, clearly enhances the educational process. Based on the above observations of teachers, librarians, doctors and researchers, SSTV, to summarize, can

Visually enhance instruction, especially important at the elementary educational levels

Make available specialized courses when they would not otherwise be accessible to students

Meet specific local educational needs without the production expense of regular TV

Make available to a wide audience scarce and/or distant intellectual and research resources and personnel

Make continuing education programs more widely available and more convenient to take for those located in remote regions or isolated due to physical handicaps

Bring the classroom to the home, workplace, or wherever convenient to the student population

Bring together a geographically-scattered group of students so that they can interact with each other and so that enrollment levels at the main educational site can be met

Provide the instructor who is teaching long-distance the benefit of direct verbal interaction and of seeing his or her audience's facial expressions

Facilitate medical research, consultation and diagnosis ■

SLOW - SCAN
TELE-TEACHING PROJECTS

ACTIVE

1. University of Wisconsin at Madison—Engineering
2. New York University—Communications
3. University of Toronto—Medical
4. University of California at Chico—Engineering
5. University of Hawaii—Sociology
6. Massachusetts Institute of Technology—Art
7. Memorial University of Newfoundland—Medical
8. University of Georgia—Medical
9. University of Iowa—Engineering
10. Oregon State University—Engineering
11. Maricopa Community College, Arizona—General
12. University of the West Indies—Medical

LIBRARY PROJECTS

1. University of Cincinnati—Medical
2. Federal Library Group—Experimental
3. University of Denver—Experimental

NO LONGER IN OPERATION

1. Northwestern University—Engineering
2. South Bend School District—Primary Schools
3. Colby Community College—Experimental
4. University of Southern Mississippi—Engineering
5. University of Southern Florida
6. University of the South Pacific—Experimental
7. University of Alaska—Primary Schools
8. Colorado State University—Engineering
9. Michigan Department of Education, Flint, Houghton—Multiple Use
10. Eastern Washington College of Education—Engineering

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